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Photographing the Retinal Image Impressed on the Living Fundus Oculi.

BY

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PHOTOGRAPHING THE RETINAL IMAGE IMPRESSED ON THE LIVING FUNDUS OCULI.

IN January, 1864, I had the privilege of reading a paper before the Canadian Institute on "Photographing the Living Fundus Oculi" This paper was published in the journal of the Institute, which was issued two months later, viz., in March, 1864. This article was copied by the scientific journals abroad and, among others, attracted the attention of Prof. Zantedeschi, of Padua, Italy, who wrote me in June following. This communication of Prof. Zantedeschi led to the production of the photographs which I have the honor of presenting to the Institute this evening; and as this communication is interesting in itself, and as I have a literal translation thereof, I will read the same. He writes as follows:

PADUA, June 28th, 1864.

DEAR SIR,—In the numbers 3 and 6 of the *Moniteur du Photographie* for the year 1864, I read with great pleasure that you have photographed the bottom of the eye of living animals, and I congratulate myself with you. I should have need, for the promotion of my studies, that you would be so kind as to make an experiment for me. Let the eye of a man be directed to an object, as, for example, a flower, whilst the image

of the flower *persists* on the bottom of the eye or on the *retina;* let the photography be executed ; does the image remain impressed on the paper (*semplilizata*) in the same way as it is seen in common photography? I expressed my philosophical opinion in a *feuilleton* entitled "La Camera Lucida." Applied to the prototypes of the external world the images are subjective, the impression is objective, and the soul or mind refers the image to the object from which the excitement or the luminous motion is derived. Be so kind as to write me and to enclose in your letter an *essay* of an eye photographed by you whilst the image of the flower *persists* on the *retina.* I give you my best thanks beforehand and remain, with high esteem,

Yours truly,

FRANCIS ZANTEDESCHI.

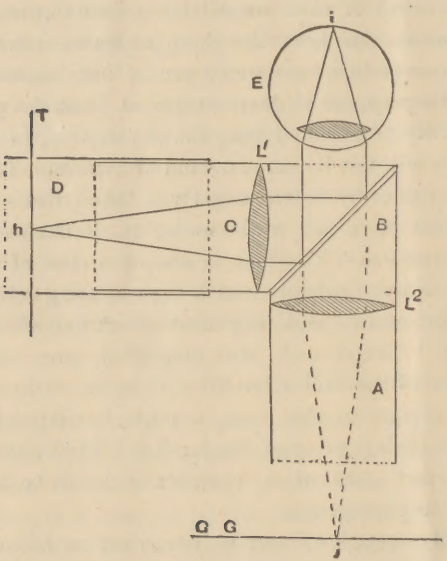
I was not able to carry out the suggestion contained in this communication until the following summer (1865), when, after several attempts, I was so far successful as to be able to demonstrate the possibility of accomplishing what Prof. Zantedeschi had in view, namely, photographing not only the living retina of the eye, but also, at the same time, the inverted image of an object to which the eye was directed. My experiments did not extend beyond this point, and I have not found it convenient to take up the subject since that time. The result fell so far short of what I believed might be

attained that I refrained from reporting the little that had been accomplished.

As, however, the subject does not seem to have been taken up by others, although 23 years have since elapsed, I desire now to report the result of these experiments, and to present some specimens of the photographs then made. These pictures are quite crude, but inasmuch as they appear to demonstrate at least the possibility of accomplishing the end desired, I trust they will not be found devoid of interest. They are prints from two negatives taken from the retina of a cat while under the influence of chloroform. The first is simply a view of the optic nerve entrance, with the radiating retinal blood vessels, and magnified about four diameters. The second, also magnified, presents a view of the ocular fundus with a dim outline of an image, in this case, a portrait, impinging upon this portion of the fundus. The ramifications of some retinal vessels are also to be seen in the photograph.

My apparatus may be described as follows: A small photographic camera with a principal focus of about three inches is used. Upon the outer end of the tube carrying the camera-lens (or lenses) is attached a T tube, one tube crossing the other at right angles. We will call the camera-tube containing the photograph lens, tube A, the tube attached thereto, tube B, and the tube meeting the latter at right angles

tube C. D is a slotted tube sliding upon tube C. In tube B is placed an elliptical shaped plate of polished plate glass, and inclined at an angle of 45 degrees to tube C. This plate glass is placed so that rays of light impinging upon



A, the camera tube. B, an extension outwards of the camera tube. C, a tube meeting tube B at right angles. D, the sliding tube for carrying the object to be photographed. E, the eye. P, the plate glass. T, the transparency. L^1, L^2, the lenses. G G, the ground glass at the back of the camera for adjusting the focus and where the prepared plate is placed. h, a single point of the illuminated object on the transparency. i, the image of this point on the retina of the eye, E. j, the photographic image of this point on the plate at the back of the camera.

its surface from tube C are directed outwards from the outer end of tube B. This plate glass partly transmits and partly reflects rays of light incident upon its surface.

While these photographs were being taken the eye of the cat was held near the opening at the outer end of tube B. The transparency was exposed to the direct rays of the sun, and the prepared plate was "exposed" about five seconds.

The principal difficulty in making these photographs arose from the fact that the cornea reflects the light very strongly. This is the case with the eye of lower animals as well as with the human eye, but in the latter a much larger proportion of the light reflected into the eye being absorbed, the light reflected from the fundus is comparatively feeble and not sufficiently intense to illuminate the prepared plate already partly illuminated by the light reflected from the cornea. Hence my attempts at photographing the human retina, or the inverted retinal image imprinted thereon, were not attended with success. As a large proportion of the rays of light incident upon the fundus oculi of the cat are again reflected, a comparative brilliant image is formed on the prepared plate, and this renders the photograph possible, notwithstanding the reflections of light from the cornea. The inside of the tubes are, of course, well blackened (especially near the part marked

B in the figure) for the purpose of absorbing all light not required in making the photographs.

The object, the retinal image of which is to be photographed, is placed near the outer end of tube D, while the eye, whose fundus is to be photographed, is placed near the end of tube B. The light from tube D, or a portion thereof, being reflected through the dilated pupil, causes a certain portion of the fundus to be illuminated. In the cat only a small percentage of the illuminating rays are absorbed. The larger part pass out of the pupil and (in this case) meeting the plate glass, a certain portion are reflected back through tubes C and D to the source of illumination, the balance of the rays are transmitted and pass through the lens to the ground-glass screen at the back of the camera. The eye of a cat being emmetropic or only slightly hyperopic, these rays of light on being emitted by the eye are nearly parallel, and, being refracted by the plate glass and the camera-lens, form a picture at the principal focus of said lens. Hence, although the eye to be photographed is very near the end of the tube, the adjustment of the camera is the same as for distant objects.

In photographing the retinal image my plan was as follows: The object to be photographed was placed in tube D. The object used was a glass transparency printed from a negative, a slot on each side of the tube being made to

admit the glass slide on which the transparency was printed. A convex lens was placed at the inner end of tube C, at its junction with tube B. The length of the focus of the lens was determined by its distance from the glass transparency; thus, if the distance from the lens to the transparency were, say, 3 inches, a lens of 3 inch focus would be used, the object being to render the rays of light from the transparency parallel before being reflected into the eye.

Tube D, being made adjustable with reference to tube C, the distance between the transparency and the lens may be adjusted at pleasure, the object being to place the transparency in that position that will give the best retinal image. If, for instance, the eye to be photographed were myopic, the transparency would be placed at a point within the principal focus of the lens, and if on the contrary, the eye were hyperopic, the transparency would be placed at a point beyond the principal focus. In the former case the rays of light reflected into the eye would be diverging, and in the latter case they would be converging.

The same principle applies in focusing the image on the ground glass at the back of the camera. In the case of a myopic eye the focus would be shortened, and in the case of a hyperopic eye the focus would be lengthened.

Although the definition of these photographs

leaves much to be desired, the fact that such photographs are possible is not without interest in itself, apart from any practical use that may be made of it. These experiments are also confirmatory of two fundamental principles in physiological optics already demonstrated by the ophthalmoscope, namely :

1. The eye is a perfect *camera obscura*, and the object to which the eye is directed forms an inverted image on the retina.

2. When the eye is illuminated it becomes a *camera lucida*, and light is reflected from the fundus. In the hyperopic, or in the emmetrepic eye, these reflected rays may be formed into an image (inverted) by means of a convex lens. In the myopic eye an inverted image is formed in front of the eye without the aid of a lens.

[Dr. Rosebrugh has shown us copies of photographs of the fundus oculi—two series. The first series represents the nerve entrance and the retinal vessels simply. The second series gives the retinal vessels and also a portrait. While the definition in these photographs is not all that could be desired, they at least seem to clearly demonstrate the possibility of attaining the end desired —Ed. Practitioner.]